ALLELOCHEMICAL RESISTANCE OF BALD CYPRESS, 
*Taxodium distichum*, HEARTWOOD TO THE 
SUBTERRANEAN TERMITE, *Coptotermes formosanus*

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Abstract—The heartwood of bald cypress, *Taxodium distichum* (L.) Rich., resisted feeding attack by the Formosan subterranean termite, *Coptotermes formosanus* Shiraki. Hexane-extracted heartwood, however, was consumed at >12 times the amount of sound heartwood eaten. A bioassay using *T. distichum* sapwood as a feeding substrate was employed to assess the anti-termite activity of successive hexane, acetone, and methanol extracts of heartwood shavings and isolates derived from the active hexane extract. Two fractions, eluted from the crude hexane extract by liquid chromatography, significantly reduced termite feeding compared to the parent extract, while a third fraction was less active than the original hexane extract. Each fraction contained one major component. All three components were structurally related diterpenes. The two most active heartwood constituents were identified by GC-MS and NMR as ferruginol and manool, while the third and least active, but most prevalent, compound in heartwood was identified as nezukol. Results of bioassays suggest that these allelochemicals act principally as feeding deterrents with accompanying termite mortality due to starvation.

INTRODUCTION

Oshima (1919) first demonstrated that natural products occurring in termite-resistant woods were more essential in conferring resistance than the woods' physical qualities. Unlike cellulose and lignin, these allelochemicals do not contribute to the structural integrity of wood, are solvent extractable, and occur in relatively small amounts, usually in heartwood (Wolcott, 1953; Sandermann and Dietrichs, 1957; Bultman and Southwell, 1976). A number of diverse compounds from resistant wood species have been reported to be toxic to termites, including the acetylenic sesquiterpenoid, chamaecynone, from Chamaecyparis pisifera D. Don (Saeki et al., 1973); 7-methyljuglone, a naphthoquinone from Diospyros virginiana L. (Carter et al., 1978); and the iridoid glycoside, loganin, from Guettarda speciosa L. (Yaga and Kinjo, 1985). Termite repellents in wood include an unknown saponification-deactivated compound from Eucalyptus microcorys F. Muell. (Rudman and Gay, 1961) and 2-furfuraldehyde from Pinus sylvestris L. (Becker et al., 1971). Scheffrahn and Rust (1983) isolated free carboxylic acids from Pinus lambertiana L. wood which deter termite feeding, and Carter et al. (1981) presented evidence that some Nearctic woods contain unknown compounds that are toxic to gut symbionts of termites. Most of these and other antitermitic agents in resistant woods probably encompass several categories of activity (Becker et al., 1972; Carter and Dell, 1981).

Bald cypress, Taxodium distichum (L.) Rich., is a widespread North American conifer ranging from Delaware to the Florida Keys and west to Texas (Harlow and Harrar, 1969). Bald cypress heartwood has been reported to resist attack by the drywood termite, Cryptotermes brevis (Walker) (Wolcott, 1957), and three subterranean rhinotermitid species, including Coptotermes formosanus Shiraki (Smythe and Carter, 1970a). In one case, bald cypress timbers used to construct buildings in Florida remained free of damage for over three centuries, although adjoining native woods were heavily damaged by termites (Ellis, 1936). Organic extracts of bald cypress heartwood deposited onto filter paper reduced feeding and increased mortality of Reticulitermes flavipes (Kollar) (Carter and Smythe, 1972, 1974). The compounds mediating this antitermitic activity were not identified.

We now report the chemical nature of major antitermitic compounds isolated from T. distichum heartwood and their activity against the Formosan subterranean termite, C. formosanus.

METHODS AND MATERIALS

Wood and Termites. T. distichum heartwood used in this study was seasoned "old-growth" lumber (7–21 annual rings/cm) collected in central Florida prior to 1944 and stored under indoor conditions until this study (1986). A